

MULTIPLE TREATMENT INTERFERENCE IN THE ALTERNATING TREATMENTS DESIGN AS A FUNCTION OF THE INTERCOMPONENT INTERVAL LENGTH

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In experimental designs requiring the administration of more than one treatment to the same subject(s), the effect of one treatment may be influenced by the effect of another treatment (Campbell & Stanley, 1963), a phenomenon known as multiple treatment interference. We conducted two studies in which multiple treatment interference in an alternating treatments design was shown to be a function of the length of the intercomponent interval (ICI) separating treatment conditions. In the first study, we evaluated the effects of four different treatments on the mouthing of a severely retarded boy. Under a 1-min ICI no consistent differential responding to treatment was obtained. Differential responding emerged when the ICI was increased from 1 min to 120 min, thus suggesting multiple treatment interference in the lack of differential responding under a 1-min changeover interval. Functional control of the nondifferential and differential responding as a function of the ICI length was replicated in a reversal phase. In the second study, we compared two treatment procedures for the disruptive noncompliant behavior of a moderately retarded boy. Multiple treatment interference (i.e., the lack of differential responding) occurred with the 1-min intercomponent interval. An increase to a 120-min ICI again resulted in differential responding. A replication of multiple treatment interference by a reversal to a short interval phase was not achieved in the second subject. Results of this study support much of the basic literature on discrimination and multiple treatment interference. Major findings of this study are twofold: Multiple treatment interference can depend on the length of the changeover interval between treatments and multiple treatment interference can take the form of a lack of differential responding to various treatments. Implications for future research are discussed.

DESCRIPTORS: alternating treatments design, multiple treatment interference, visual screening, mental retardation

The alternating treatments design (Barlow & Hersen, 1984) is widely used in single-subject experiments. The design is generally used to compare the effects of two or more treatments on the behaviors of one individual. The comparison is based upon the rapid alternation of treatments in close temporal proximity, thereby exposing the subjects to all treatments, with extraneous events supposedly remaining constant across treatments. The sequence of the treatments is usually counterbalanced across sessions and each treatment condition within the

session is separated by short breaks, which are called intercomponent intervals (ICI). The intervals are designed to reduce treatment interference, or the degree to which one treatment condition influences behavior under an alternating and different treatment.

A critical problem with the alternating treatments design in both basic and applied research is susceptibility to multiple treatment interference. Multiple treatment interference refers to error variance in the data due to the administration of more than one treatment to one individual. Targeting easily reversible behaviors, providing treatments with little or no carryover effects, and using discriminative stimuli to signal the onset of a particular treatment have been used to reduce multiple treatment interference (Barlow & Hersen, 1984; Barrett, Matson, Shapiro, & Ollendick, 1981; Barrios, 1984; Greenwald, 1976; Kazdin, 1982; Ollendick, Shapiro, & Barrett, 1981).

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Basic research on "behavioral contrast" and "induction" in multiple schedules has shed light on the nature and determinants of treatment interactions (e.g., Schwartz & Gamzu, 1977, p. 72). When the reinforcement schedule for one component of a multiple schedule is altered, the behavior under the unchanged component may also change, sometimes in the same direction as the behavior in the altered component (induction) and sometimes in an opposite direction (contrast). Investigators have discovered that the treatment interference or carryover effects from one treatment to the next are often transient and have proposed a number of explanations for the phenomenon, including the inability of subjects to discriminate between conditions (Blough, 1983; Hinson & Malone, 1980; McLean & White, 1981). One important implication of the basic literature is that multiple treatment interference may operate in alternating treatments designs and obscure the differences between treatments that could be observed in the absence of treatment interference.

Barlow and Hayes (1979) have argued that the testing of two or more treatments in the same subject within the same time period produced an elegant control for most threats to internal validity. Given the power of the alternating treatments design to rule out rival hypotheses and its continuing popularity among applied researchers, assessment of the degree to which treatment interference occurs in such designs and the factors responsible for such interference is needed.

To date, only a few applied research studies using alternating treatments designs have confirmed and reported multiple treatment interference as a factor in research outcomes. Shapiro, Kazdin, and McGonigle (1982) assessed whether specific treatments would differentially affect target behaviors depending on the treatment to which it was compared. They also investigated whether the sequence of treatment presentation affected outcomes. Following a baseline period, a token reinforcement program for attentive classroom behaviors was implemented for one of two time periods each day. The token reinforcement remained constant and in effect throughout the investigation. In some phases, the token reinforcement program was alternated

with a baseline condition and in other phases it was alternated with response cost. The investigators found four different kinds of evidence of multiple treatment interference in the data: (a) Visual inspection of the data indicated that for some subjects there was a difference in mean levels of on-task behavior when alternations were made between either baseline or response cost conditions; (b) on-task behavior was more variable during the token reinforcement condition when alternated with response cost than when the token program was alternated with the baseline condition; (c) lower levels of target behaviors were noted when the baseline followed response cost than when it preceded an active treatment component; and (d) on-task behavior under token reinforcement was consistently higher when token reinforcement preceded rather than followed response cost (sequence effect).

Johnson and Bailey (1977) found similar sequence effects using a multiple treatments design. In this study, one intervention (making requisite materials available) was found to be more effective in increasing participation in leisure activities in mentally retarded women when presented before rather than after the second intervention (making materials available and providing rewards).

The present paper focuses on yet another variable that could be related to multiple treatment interference: the duration of the changeover time between conditions, which we refer to as the inter-component interval (ICI).

STUDY 1

METHOD

Subject and Setting

The subject was a severely retarded boy (3 years 8 months old) with an overall developmental level of 7 to 9 months. The subject had a variety of medical problems including a seizure disorder. He showed extremely low levels of self-care skills, attending behaviors, and social behaviors as well as high levels of aggressive and self-injurious behaviors. The subject also displayed a high rate of mouthing behavior (e.g., objects and fingers) that greatly interfered with the acquisition of adaptive

skills. Throughout the course of hospitalization, anticonvulsant medications (Depakene, Meberol, and Tegretol) were administered without obvious impact on seizure activity (staring spells).

All observations took place in a special education classroom housed in an acute psychiatric care facility. The room was staffed by one teacher and two classroom aides. The subject participated in a variety of activities throughout the day. The classroom contained developmentally appropriate work and play materials that were held constant across all phases of the study. During the observation sessions, one staff member was assigned to implement and carry out the prescribed interventions.

Behavioral Assessment

Three observers (including the first author) used frequency counts to assess the level of mouthing behavior during 45-min sessions in which the subject was engaged in work and play activities by the teacher and classroom staff. The subject's mouthing was a clear and discrete act of short duration (5 to 10 s) and an absolute count appeared to be an effective and reliable means of measuring the target behavior. Observers were located in an adjacent observation booth behind a one-way mirror. Mouthing was defined as any contact of the subject's lips with inedible objects or his hand or fingers. Eighteen interobserver agreement checks were performed across all baseline and treatment phases.

Treatment Conditions

The effects of four treatment conditions on mouthing behavior were evaluated.

Interruption/verbal redirection. The trainer used a verbal prompt ("No") and a mild physical prompt to interrupt every episode of mouthing and redirected the subject to a more appropriate activity. The discriminative stimulus (S^D) associated with this condition was a low-tone buzzer.

Differential reinforcement of other behaviors (DRO). During this condition, social praise was delivered after every 20 consecutive s without mouthing. Reinforcement history and observation by the classroom teacher suggested that social praise was the subject's most potent reinforcer. An audiotape of classical music served as the S^D.

Visual screening. When mouthing was observed, the therapist placed one hand over the subject's eyes while placing the other hand firmly on the back of the subject's head to preclude visual input. Duration of the screening ranged from 5 to 20 s. This condition was paired with a vibrator which the subject held in his hand.

Extinction. During this condition episodes of mouthing were scored but no response consequences were delivered. A flashlight that was turned on and held by the subject signaled this condition.

The various tactile and auditory stimuli chosen as S^Ds were randomly assigned to the treatment conditions. The S^Ds were based on the subject's preference for these stimuli as reported by the teacher. Each of the S^Ds was presented for a continuous 20-s period prior to the start of each assigned condition.

Experimental Design and Procedure

A combination of an alternating treatments design (to compare the relative effectiveness of four treatment conditions on the reduction of mouthing behavior) and a withdrawal component (to demonstrate control over multiple treatment interference) was used.

In Phase A (see Figure 1) mouthing was recorded during a 40-min period within the classroom setting in which only interruption/redirection was in effect. This procedure was the "naturally occurring" program that was used by the staff in the classroom. This 40-min observation period was broken down into four 10-min observation periods with a short interval (1 min) between observations. There were no S^Ds presented to the subject during this period.

In Phase B, all four treatment conditions (visual screening, differential reinforcement, interruption/redirection, and extinction) were presented in a counterbalanced and rapidly alternated fashion with a 1-min ICI between conditions. Each of the treatment conditions was in effect for 10 min. Prior to the start of each assigned condition, the subject was presented with the S^D assigned to each of the four conditions.

This was followed by a second Phase A, in which interruption/redirection was the only active intervention. This phase was conducted in the same

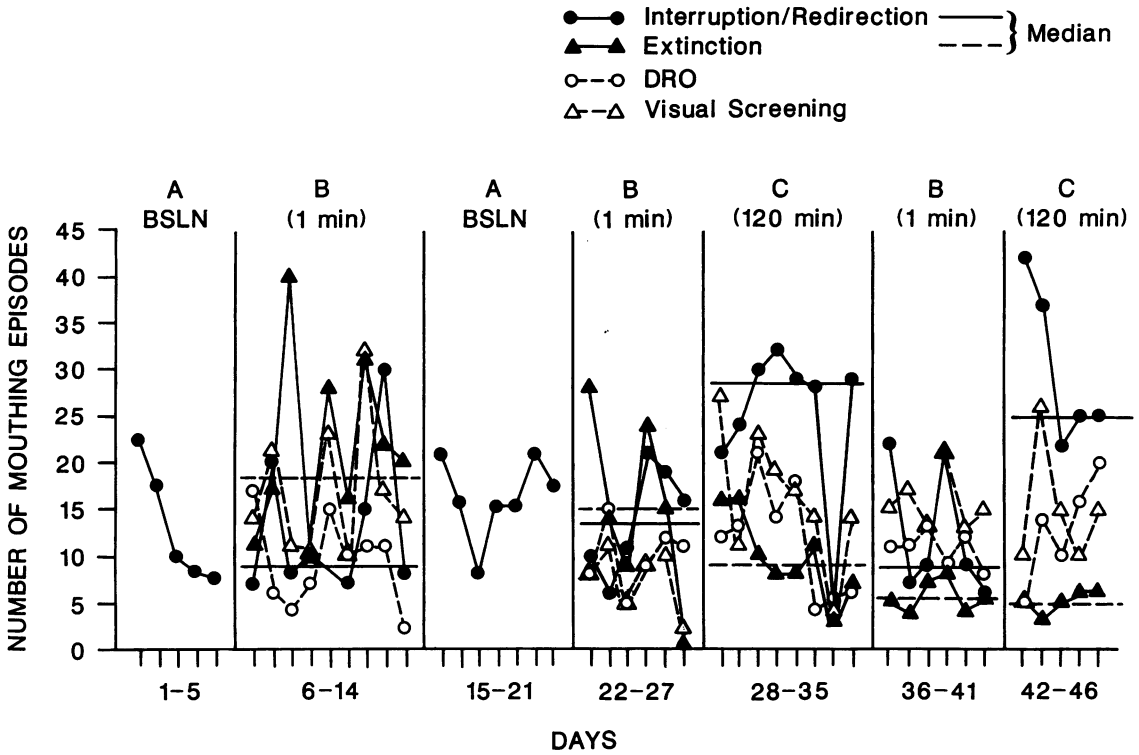


Figure 1. Data points represent the number of mouthing episodes during 10-min treatment segments. Data in Phase A represent the mean of four 10-min segments daily.

manner as the initial baseline. The 40-min observation period was again broken down into four 10-min observation blocks with a 1-min ICI.

Phase C reimplemented the counterbalanced presentation of the four conditions; however, a 2-hr ICI was introduced between conditions. Each of the four treatment conditions was in effect for 10-min. The 10-min treatment periods were scheduled daily at 9:00 and 11:30 a.m. and 1:30 and 3:30 p.m.

A return to Phase B reintroduced the short ICI (1 min) between conditions. The 10-min treatment periods were implemented daily between 10:00 and 11:00 a.m. with a 1-min ICI and a 20-s presentation of the S^P.

The last phase of the study consisted of a final replication of Phase C in which the treatments were once again implemented with a 2-hr ICI between conditions.

RESULTS AND DISCUSSION

Two independent observers recorded data for 18 sessions. Interobserver agreement was calculated on a session-by-session basis by dividing the smaller frequency by the larger frequency and multiplying by 100%. Interobserver agreement ranged between 88% and 100% with a mean of 94% for occurrence only.

The data in Figure 1 suggest that extinction was the most effective treatment for reducing mouthing behavior. However, differential effects did not appear until the ICI between conditions was increased from 1 min to 120 min. Extinction appears to have resulted in an increase in responding in the first treatment phase compared to baseline, possibly as a result of an extinction burst. There was no significant difference between DRO and visual screening in reducing the rate of the target behavior. Overall, the data suggest that differential respond-

ing to the interventions was not clearly observed when the conditions were separated by 1 min. When the ICI was increased to 120 min (see Phase C), differential treatment effects were observed between interruption/redirection and extinction.

STUDY 2

The second experiment assessed the effects of different changeover intervals on the discrimination between conditions with a moderately retarded subject. Two treatment conditions were chosen to attempt to reduce the chances of multiple treatment interference.

METHOD

Subject and Setting

The subject was a moderately mentally retarded child (3 years 10 months old) with attention deficits and a number of behavior problems, including stereotypic behaviors, aggressive behavior, and severe noncompliance. The Bayley Mental Scale of Infant Development yielded an age equivalent of 19 months. The subject displayed deficits in adaptive behavior and developmental delays in other areas (e.g., speech and motor skills).

A morning session during group circle activities and an afternoon session during structured free play activities were conducted 5 days a week. During circle activities the group of six children sat around the teacher practicing expressive and receptive language skills and turn-taking in the context of activities such as matching colors and shapes and identifying objects. Verbal approval and hugs were delivered contingent upon appropriate behaviors. During structured free play the children played with a standard set of developmentally appropriate toys.

Behavioral Assessment

Observations were conducted for two 7.5-min periods during each activity. The short time periods were chosen because the rate of the target behaviors was high and the 7.5-min observation period provided a representative sample. The percentage of intervals with disruptive noncompliance was re-

corded using a continuous 10-s interval recording system. Disruptive noncompliant behaviors included whining, screaming, throwing objects, touching peers or peers' chairs or materials, out-of-seat behavior, and spitting. Two observers independently scored the behavior during 18 sessions, at least once per experimental phase.

Treatment Variables

The effects of visual screening and DRO on disruptive noncompliant behavior were evaluated. Both procedures were implemented as described in Study 1, except that the DRO (value 20 s) was administered contingent upon compliant responding. Small edibles with proven reinforcement value were used as reinforcers.

Experimental Conditions and Design

An alternating treatments design was used to compare the effectiveness of visual screening and DRO. A reversal design was used to assess the effects of ICI length.

Morning and afternoon experimental sessions were conducted daily. Each session consisted of two 7.5-min segments, which were separated by 1-min intervals. During baseline (Phase A), no interventions for disruptive noncompliant responding other than those necessary to protect the subject and the other children were used. After 5 days (session 5) the teacher began to use two color photographs (8 by 10 in.) as S^Ds. These picture cards were presented for a 20-s period at the start of each 7.5-min segment in a modified baseline phase (B). One photograph depicted a child being visually screened. The other photograph showed edibles to be used as DRO reinforcers. During Phase B the cue cards were presented during circle time in a counterbalanced manner for 20 s and were accompanied by the following statements: "This is what happens when you don't follow directions" (visual screening), or "This is what you get for good listening" (DRO). No S^Ps were used in the free play setting. No contingencies were in effect and Phase B was introduced to confirm that the cue cards alone would not alter the target behavior.

In Phase C two active treatments, DRO and visual screening, were introduced for disruptive noncompliance. The treatment conditions were counterbalanced and alternated within each session, so that each treatment was applied for two 7.5-min segments per day, once for each of the two activities. The relevant S^D was visually presented to the subject for 20 s prior to initiating each 7.5-min treatment period. The ICI between the two treatments was 1 min.

For the next three sessions (Phase D) the ICI was increased to 120 min between the treatment conditions. This was accomplished by holding the duration of each condition at 7.5 min and implementing one treatment in the morning session and one in the afternoon session and counterbalancing the order across days rather than within sessions as in Phase C. The time between morning and afternoon sessions represented the ICI between different treatments, which was held constant at 120 min. In Phase E, DRO was replaced by a no-treatment condition such that the no-treatment condition alternated with the visual screening condition. The ICI remained at 1 min and condition durations were 7.5 min.

In the final phase (F) of the study, visual screening, the most effective procedure, was implemented across the morning and afternoon sessions with a 1-min ICI. (On Day 39 a controlled trial of Ritalin was begun.)

RESULTS AND DISCUSSION

Interobserver agreement was assessed by dividing the number of agreements by the number of agreements plus disagreements on the occurrence of the target behavior within each interval and multiplying by 100%. Session agreement percentages ranged from 81% to 99%, with a mean of 92%.

The data in Figure 2 show that visual screening was more effective than DRO in suppressing disruptive noncompliant behavior but that differential responding did not emerge until the 120-min ICI was implemented. Baseline revealed no consistent difference in the level of disruptive behavior during circle and free play activities, a result that did not change with the addition of visual stimuli associated with each activity.

A lack of differential responding was observed with the 1-min ICI. After increasing the ICI to 120 min, differential levels of behavior between the two treatments were observed. A return to the 1-min interval (Phase C), however, did not replicate the multiple treatment interference observed during the first 1-min ICI condition; visual screening continued to be more effective than DRO in reducing the target behavior. It appears that the increase in ICI facilitated treatment discrimination for this subject. Further, the data suggest that differential responding may not be reversible with some subjects after it has been established. The data from the final phase show that visual screening, when alternated with itself rather than with a different treatment, continued to produce levels of behavior as low as or lower than it produced in earlier phases.

GENERAL DISCUSSION

Taken together, these studies suggest that multiple treatment interference is affected by the length of the ICI between treatments. We suggest also that the increased ICI facilitates the discrimination between the specific treatments, thus promoting the emergence of differential responding under alternating treatment conditions.

Multiple treatment interference has been a problem in both basic and applied research (Barlow & Hersen, 1984; Ollendick *et al.*, 1981). In applied situations the treatment conditions often consist of more than one active treatment, so that multiple treatment interference can be reciprocal in that all treatments potentially affect one another. Multiple treatment interference has been reported as changes in variability of data, and may depend on the nature of juxtaposed treatments (Shapiro *et al.*, 1982). Interference has also been related to the sequence of treatment presentation (Johnson & Bailey, 1977; Shapiro *et al.*, 1982). Currently there are few applied studies that show the presence of multiple treatment interference and experimentally analyze variables responsible for the interference. Results of our studies show that multiple treatment interference can be present in alternating treatments designs and that differential treatment effects can be highlighted and, in the case of Study 1, subsequently obscured by increasing and decreasing the ICI.

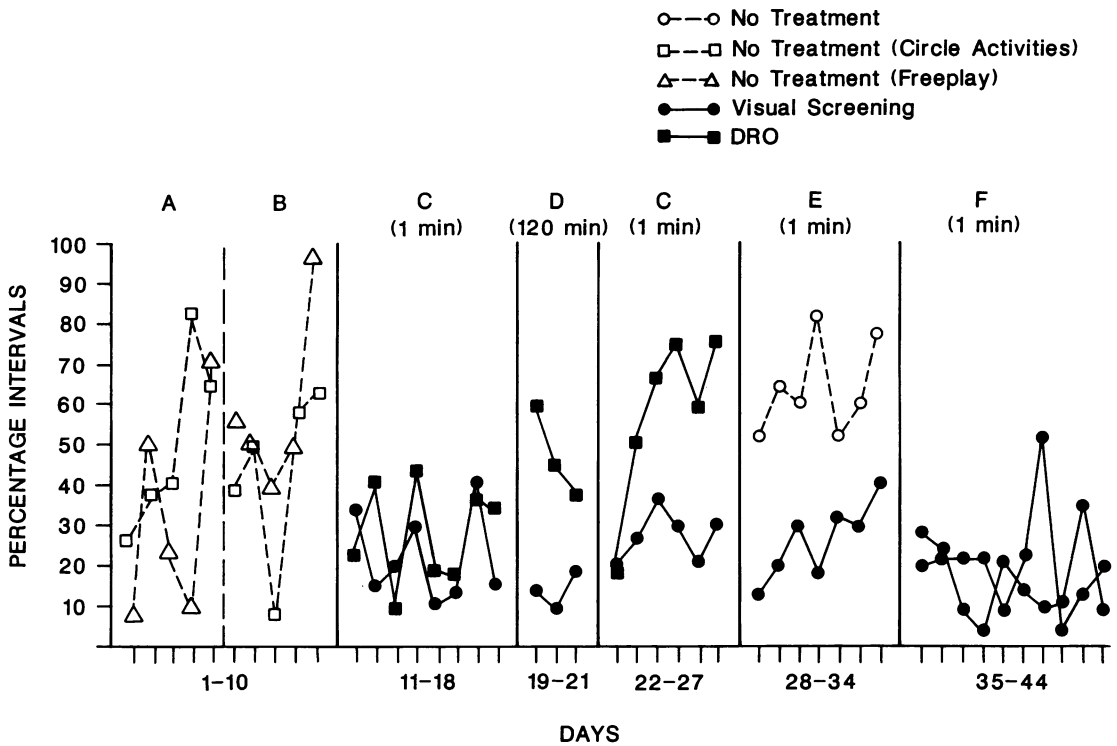


Figure 2. Each data point represents the percentage of 10-s intervals in a 15-min treatment session (combination of values from two 7.5-min segments) the subject engaged in disruptive noncompliance in each of three conditions.

The extent and generality of multiple treatment interference in alternating treatments designs are not currently known, but we know of at least one report of a phenomenon similar to that reported herein. Watson, Singh, and Winton (1986) compared the effects of visual screening and facial screening on the reduction of self-injurious behavior in two profoundly retarded adolescents using an alternating treatments design. Interestingly, differential treatment effects were observed for Subject 1 who had an ICI of 5 min; no differential effects were observed for Subject 2 with an ICI of only 1 min. Perhaps extending the duration of the ICI for Subject 2 would have allowed the emergence of differential treatment effects for this subject also. Adding a short "rule out" phase to the design that included extending the time between conditions to 5 min may have been sufficient for the second subject to discriminate between the conditions, thereby reducing treatment interference and making differential treatment effects more clear.

Barlow and Hersen (1984) suggest that an in-

crease in the time period between conditions may, within certain limits, reduce the likelihood of multiple treatment interference. However, too long a changeover interval may diminish the main asset of the alternating treatments design, namely, that conditions take place under equal extraneous conditions. Additional research is needed to clarify the impact of ICI, treatment sequence, and discriminative stimuli on the ability of alternating treatments designs to differentiate between the effects of two or more treatment conditions.

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